looking back

"The mouth will open, the teeth will gnash, the eyes roll in their orbits, appearing as if the animal was restored to life. . ."
***John Cuthbertson,* 1807**
(describing a popular use of the voltaic "pile")

Beyond the voguish, albeit gruesome, parlor tricks of making decapitated animal heads perform — (even Volta admitted that he found it amusing to make headless grasshoppers sing while experimenting) — the voltaic "pile" was key to developing electricity. The "pile," invented by Alessandro Volta, was the first electric battery and continuous source of electricity. He designed it to disprove Luigi Galvani's theory that animal tissue (muscle) contained "animal electricity" which was made evident upon contact with materials such as metals. The voltaic pile more than succeeded. After the invention of the pile, others opened up the field of electrochemistry followed by the study of electromagnetism.

Alessandro Giuseppe Antonio Anastasio Volta was born February 18, 1745 in the town of Como, Italy.

In early childhood, Alessandro Volta appeared to be dull-witted. He did not speak until he was four years old. At four, however, his brain cells started clicking and by seven he was considered exceptionally bright.

Although both parents were from patrician families, Volta's father was an exceptionally poor manager of money. So, Volta's education often depended on the generosity of others. In particular, relatives who were in the Church made sure Volta received a good education.

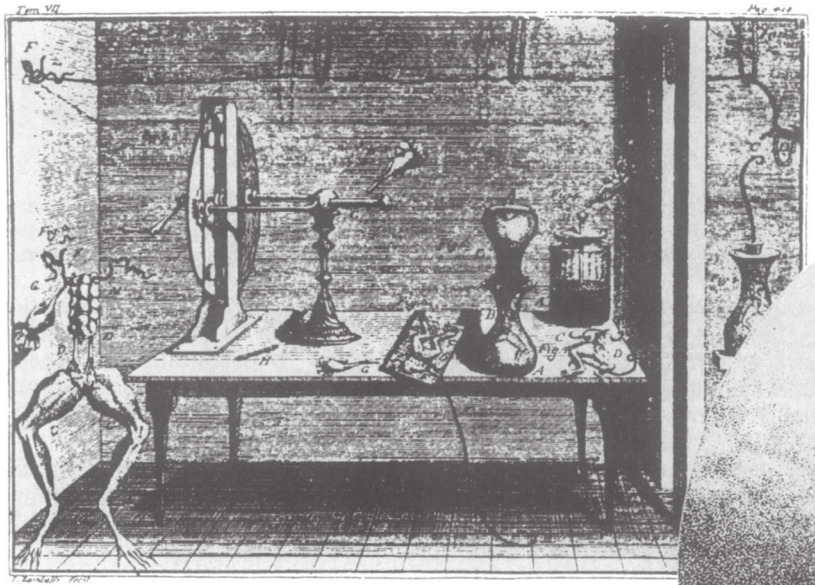
Volta knew from age 14 that he wanted to be a physicist. So when pressure was exerted by his relatives and family to enter the priesthood, he steadfastly refused. He opined that with countless other religious relatives, his help was not needed for the family to stay on good terms with the Almighty.

In 1769, Volta published a Latin dissertation, "De vi attractiva ignis electrici," which reinterpreted Benjamin Franklin's theory of the "unique attractive" principle. This was his first study of electricity.

In October 1774, Volta took his first academic job as principal or regent of the state Gymnasium in Como where in 1775, he obtained the professorship of experimental physics.

That year, Volta announced the invention of the electrophorus in a letter to Joseph Priestly (1733-1804). He wrote that, "electrified but once, briefly and moderately, (it) never loses its electricity, although repeatedly touched, obstinately preserves the strength of its signs." For the first time experimenters had a steady, replenishable supply of static electricity.

The following year, while fishing on Lake Maggiore, Volta noticed bubbles surfacing on the swampy areas of the lake. He took a sampling of this marsh gas (known today as methane) and found it to be inflammable. In experimenting, Volta found that hydrogen with common air ignited more readily and burnt more fiercely than methane and air. This discovery led to Volta's "inflammable air pistol" filled with hydrogen and oxygen, and fired by a portable electrophorus. This artillery



Courtesy of the Burndy Library.

Dr. Luigi Galvani found that dissected frog legs would "kick" when touched by metal in the presence of electricity. (Electrostatic machine shown at left on table; Leyden jar shown at right on table.) Due to his medical training, Galvani maintained that the kick was caused by the frog's own electrical properties. Galvani was not completely wrong in claiming that animal tissues are capable of generating electric current as we know today. However, in this case the stimulus was the electricity generated chemically by contact of dissimilar metals as Volta proved with his voltaic "pile."

Alexandre Volta

0278-6648/87/1000-0055$01.00© 1987 IEEE

could "fire a lead ball with force enough to dent wood at fifteen feet," he later wrote.

During the course of finding the best mixture ratio, Volta discovered oxygen was one fifth the total for "common" air. Volta's results were confirmed by Humboldt and Gay-Lussac who found oxygen occupied about 21 percent of the volume of "common" air.

In 1778, as a result of his work, Volta was appointed professor of experimental physics at the prestigious University of Pavia. He held the post for nearly forty years, during which time he proved to be very popular. A new lecture hall was built to accommodate attendance and the university's ever-increasing collection of instruments. Many of the instruments Volta bought at state expense on state-financed trips to France, England, and Germany to confer with the leading minds of the time.

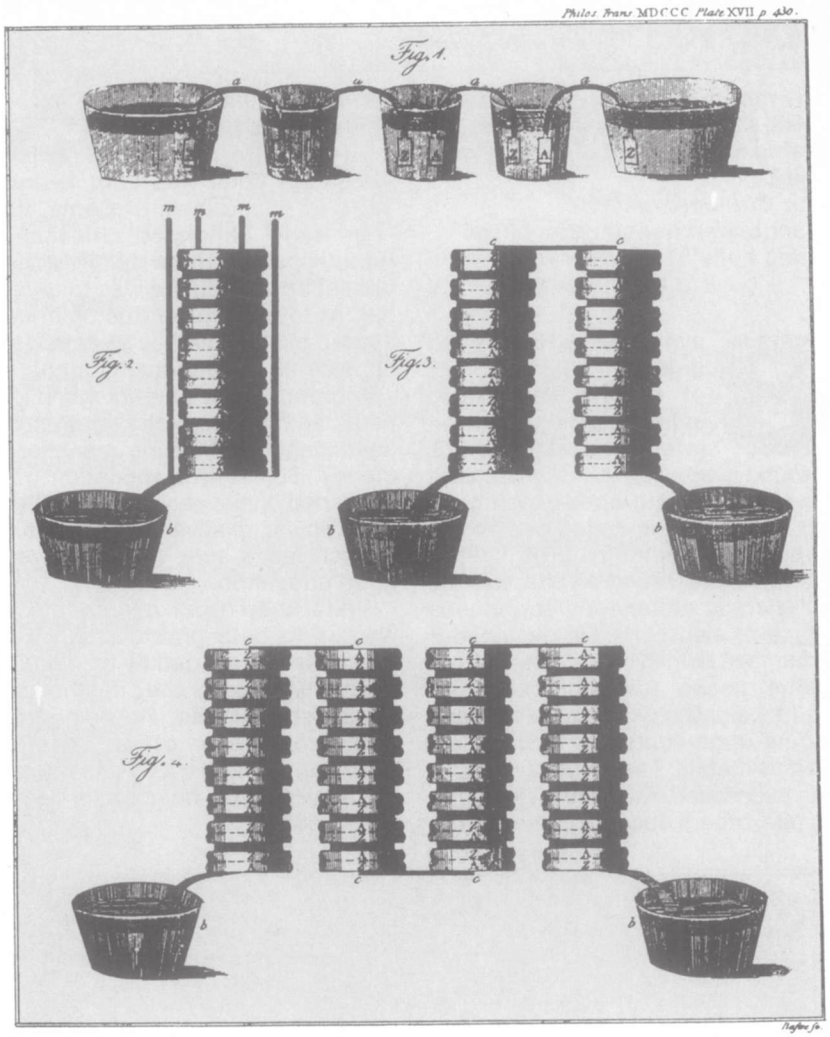
Volta was a painstakingly careful experimentalist. Although Volta's work contains little mathematics, he did understand the need for measurement, "Nothing good can be done in physics unless things are reduced to degrees and numbers." This attitude led to inventions such as the electroscope announced in 1782 — a much more sensitive indicator of electricity's presence than earlier devices. Even the earlier electrophorus Volta regarded as primarily an apparatus to facilitate measuring electric charges rather than as a generator of static charges.

Volta reached the peak of his popularity in 1801 when he was invited to Paris by the National Institute of France to demonstrate some of his experiments.

He was so popular that Napoleon, then the most important figure in France, attended many of Volta's lectures. Napoleon even helped with the experiments, drawing sparks from the pile and decomposing water into its elements on one occasion. (When Napoleon's army had conquered Italy in 1796, the City of Pavia had sent Volta along with others to negotiate with Bonaparte favorably remembered Volta.)

Counter to custom, the National Institute of France voted Volta, a foreigner, the gold medal by acclamation. Volta also received a purse of 6000 francs. Napoleon, not satisfied, conferred many more honors upon Volta, including the medal of the Legion of Honor, and raising him to the level of "Conte" and Senator of the realm of Lombardy.

Perhaps most importantly, on December 24, 1801, Volta gave a talk on the identity of electrical fluid and galvanic fluid (by which he meant frictional electricity derived from a voltaic pile). Present was a young professor of mathematics, Andre-Marie Ampere who, twenty years later, formulated the primary laws governing electric currents.



The illustration in Volta's letter to Banks shows four variations of the new electric battery. At the top is shown the "crown of cups" and below it variant arrangements of A (silver, for argentum) and Z, zinc discs with moist paper separators.

Despite the accolades given by Napoleon to Volta, when Napoleon fell from power, Volta did what everyone else in his region did: He quietly returned to being a good Austrian subject. He was a pragmatic man who wanted to live out his time quietly on his country estate in Camnago. He retired in 1819 from the University of Pavia. Volta lived on his estate with his wife, whom he married after turning 50, three children and two brothers. He died at the age of 82 on March 5, 1827.

Interestingly, before announcing his voltaic pile invention in 1800, Volta issued more than 80 letters, articles, and books in the original language or as a translation. Afterwards, he showed very little creative talent. Even though he lived an additional 27 years, after his 1800 letter to Sir Joseph Banks, president of the Royal Society of London, Volta published only six subsequent, unimportant, contributions.

At the First International Electrical Congress held in Paris in 1881, the unit of electric potential (or potential difference, or electromotive force) was named volt in his honor.

Note: To obtain a free copy of, *Volta, Ohm and Kirchoff: Electrical Engineering's Forgotten Immortals,* from which this article was derived, write or call: Dr. F. S. Shoucair, Brown University, Dept. of Electrical Engineering, Box D, Providence, RI 02912. Telephone: (401) 863-2655.

—F. S. Shoucair
Brown University